HortScience 59(1):11–15. 2024. https://doi.org/10.21273/HORTSCI17494-23

Discrepancies in University of California Fig Breeding Records

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Keywords. caprifigs, persistence

Abstract. **A 1975 fig crop reference chapter written by W.B. Storey contains pedigree information involving 30 cultivars from the University of California breeding program and early California. The data were compared with the records from the US Department of Agriculture and statements from two other sources. Graphical representations were used to determine differences among the authors. All data are supplied in this article and supplemental materials. An estimate of correct parentage is presented in the final graph.**

This report was motivated by a multiyear discussion with colleagues about the history of fig breeding in California, especially the lineage from caprifig 'Croisic' to common fig 'Tena'. Over time it became clear that several of these individuals were focused solely on a few historical works, were not keen on using US Department of Agriculture (USDA) online databases, and were not interested in long lists of pedigree successions. Thus, the idea for an article that graphically compared the two main sources of information was born.

The following historical information is provided as background for this subject. California experienced an agricultural "gold rush" during the latter part of the 1800s. Fruit trees were a major component, including figs. In 1922, the University of California (UC) began a statewide crop development program for fig (Doyle et al. 2003). The program was spread across UC facilities and has included several signatories at multiple levels. Ira J. Condit became well-known during the first period of this program because of his skillful evaluation of fig crops. He retired from UC Riverside in 1951 (Condit 1888–1967) to write an annotated bibliography of fig varieties titled "The fig: a monograph" (Condit 1955).

In 1954, UC Riverside hired William B. Storey to establish an Agricultural Sciences Department. Afterward, he became professor and chair, and then a signatory in the UC fig development program. In the 1970s, W.B. Storey contributed a chapter regarding fig development in California to the Purdue University Press series "Advances in fruit breeding" (Storey 1975). It was based, in part, on the doctoral thesis of his student W.F. Saleeb (Saleeb 1965). W.B. Storey retired in 1975. Breeding and crop evaluation activities continue today, but on a smaller scale, and they are primarily located at the UC Kearney Agricultural Center under the guide of faculty at UC Davis.

Toward the end of the 1980s, the USDA began aggregating various federal and state germplasm collections into National Clonal Germplasm Repositories (NCGR). Many of the fig specimens ended up at the NCGR Davis site at Wolfskill Orchard in Winters, CA, USA. At that time, historical accession information and breeding records were entered into the USDA sister system, Germplasm Resources Information Network (GRIN). Unfortunately the breeding records in the GRIN system do not match those in W.B. Storey's account.

Materials and Methods

Storey's chapter. On the fifth page (page 572) of W. B. Storey's chapter, he describes three horticultural types of figs. He provides statistics said to be from I.J. Condit's 1955 monograph, but the data do not match Condit's text. A summary of this is provided in Table 1. It is concerning whether Storey studied the monograph or relied on hearsay.

Further, he began a section titled "Selection of parents" on page 580 and wrote, "The several caprifigs used for breeding today are types with persistent syconia which trace their pedigrees back to 'Croisic'." This is an important statement because Condit provided the following assessment of his 'Croisic' specimen on page 336 (Condit 1955): "color greenish yellow; interior white; edible pulp insipid, lacking in sugar; staminate flowers few, generally lacking in pollen."

W.B. Storey's final section, "Achievements and prospects" began on page 584, where he listed four new fig cultivars Conadria, DiRedo, Flanders, and Excel, without providing heritage. In his Table 5 (page 585), Storey supplied descriptions of these cultivars and their pedigree numbers. The listed number for 'Conadria' is '143–5', which was known during Condit's tenure as a separate accession (discussed later in the NCGR Davis section).

On page 585, he began a subsection titled "Achievements with caprifigs." On that page, Storey noted the following: "Three superior caprifig trees having persistent syconia have been selected as pollen parents for breeding for fruit quality. … The staminate flowers produce copious amounts of fertile pollen."

For these, he provided the description and pedigrees of '228–20', '271–1', and '278–31'. Seven new hybrids (meaning male × female cultivar crosses) were detailed in Table 6 (page 587). The parentage of '284–11' ('276–14' × '276–1') in Storey's Table 6 conflicts with his description of '284–11' on the same page: "Sibmating Pedigree 276–14 fig with 276–31 caprifig yielded progeny 284, the first ever to have 'Sari Lop' genes from both parents. A superior 'Sari Lop'-like selection, Pedigree 284–11, has been made from this progeny (see Table 6)."

Figure 1 illustrates the ancestries of these figs as described by W.B. Storey. Details of Storey's records and their assembly into graph form are provided in Supplemental Table 1.

Saleeb's dissertation. Wadie F. Saleeb wrote an important PhD dissertation highlighting the exclusive role of caprifigs in providing the persistence (noncaducous) trait to female *F. carica* figs (Saleeb 1965). In his glossary beginning on page 71, he provided the following definition: "Croisic: a class of caprifig varieties having persistent, succulent, palatable syconia; from a variety of the same name. Category also known as F. carica f. relicta. Syn. Cordelia."

For the designation *forma relicta*, W.F. Saleeb cited (Eisen 1896). The concept of Croisic being a class of caprifigs was either ignored or glossed over by W.B. Storey.

W.F. Saleeb documented the outcomes of large sets of breeding trials with a gamut of caprifigs and female figs. Among them was

Table 1. W.B. Storey's descriptions of fig types in I.J. Condit's monograph versus actual content.

Storey 1975	Condit 1955
Cultivars of the Smyrna type usually do not produce a breba crop	122 Smyrna types are listed in the monograph. 19 contain breba crop data: Taranimt — productive Sari Lop — fair Scancaniso, Taurisano — occasional Remaining 15 — none
Condit described 21 San Pedro types	10 in section 11 and 12 in section 12
Condit described 470 Common types	>480
Condit described a total of 637 named cultivars	>700
The important commercial or breeding figs described by Condit are 'Archipel', 'Beall', 'Conadria', 'Dottato', 'Genoa', 'Marseilles', and 'Verdone'	Conadria is not in Condit's monograph; it had not been released

Received for publication 21 Sep 2023. Accepted for publication 16 Oct 2023.
Published online 5 Dec 2023.
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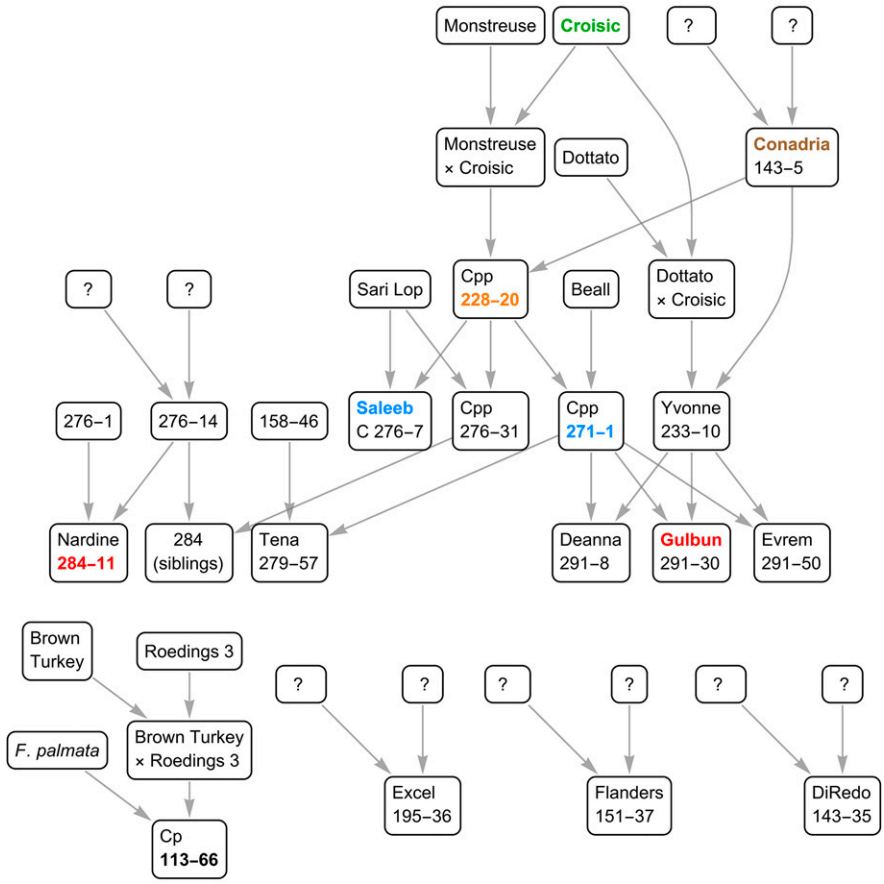

Fig. 1. University of California fig breeding according to W.B. Storey's chapter (Storey 1975). Question marks emphasize information not provided by W.B. Storey. Cpp = persistent caprifig; Cp = caducous caprifig; C = persistent female. The label 'Croisic' (green) likely does not refer to the cultivar of that name, but rather the class of caprifigs discussed by Eisen (1896) and Saleeb (1965). 'Conadria' (brown) is listed with pedigree number '143–5', which was known as a different breeding cultivar during Condit's tenure. Storey also wrote that 'Saleeb' was a proposed name for '276–7' (highlighted blue); however, it was eventually assigned to '271–1', as was 'Enderud' to '228–20' (highlighted orange). In the same manner, Storey indicated 'Gulbun' for '291–30' (highlighted red); however, later, it was assigned to '284–11' and 'Nardine' was discontinued. Storey devoted a paragraph of discussion to '113–66' (bold, bottom left), stating it was selected for use in caprifying 'Sari Lop'. If it still exists, then this cultivar could be important for other fig-producing regions of the world where caprification is practiced.

the caprifig 'Kearney', which was named for Kearney Park in Fresno, CA, USA. It had been previously documented by I.J. Condit as beneficial in "coastal-influenced locations," although "seldom found in commercial fig districts." For this report, it is important to note that 'Kearney' was among the caprifigs that did not produce persistent offspring.

GRIN records. A large table of data containing 420 records of information regarding USDA GRIN *Ficus* spp. accessions (USDA 2022) was downloaded in serial format and

Table 2. Specimens appearing in pedigree listings of both W.B. Storey (Storey 1975) and the US Department of Agriculture (USDA) Germplasm Resources Information Network (GRIN) records (USDA 2022).

Specimen	Pages in W.B. Storey	USDA GRIN ordinals
Beall	572, twice; 585	1, 5, 14, 15, 18, 36, 37, 41, 43, 44, 45
Calimyrna (syn. Sari Lop)	572, twice; 574, 5 times; 581, twice; 582, twice; 586, twice; 587, 6 times	Not in 4, 6, 7, 9, 11, 13, 16, 17, 21, 23, 27, 31, 35
Conadria	572, twice; 573, 3 times; 581; 584, 3 times; 585, twice; 589; 587	21
DiRedo	584, 3 times; 585; 586	9
Excel	584, twice; 586	11
Flanders	571; 584, 3 times; 585; 586	4
F. palmata	582	13
Gulbun	587	15, 42, 44
Kadota (syn. Dottato)	572, twice; 581; 584, twice; 587	1, 11, 18, 29, 46
Monstreuse	585	1, 2, 3, 5, 8, 10, 12, 14, 15, 18, 22, 33, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 47, 48
Tena	587	12, 36, 47
UCR 143–5	585	3, 20, 46
UCR 228–20	585, 4 times; 587	2, 3, 5, 8, 10, 12, 47, 48
UCR 233–10	587, 3 times	1, 18, 46
UCR 271–1	585; 587, 4 times	1, 5, 14, 18, 37, 43
UCR 276–14	587, twice	10, 37, 41
UCR 276–31	585, 3 times; 587	42.
UCR 284–11	587, 3 times	39, 42
UCR 291–30	587	1, 18

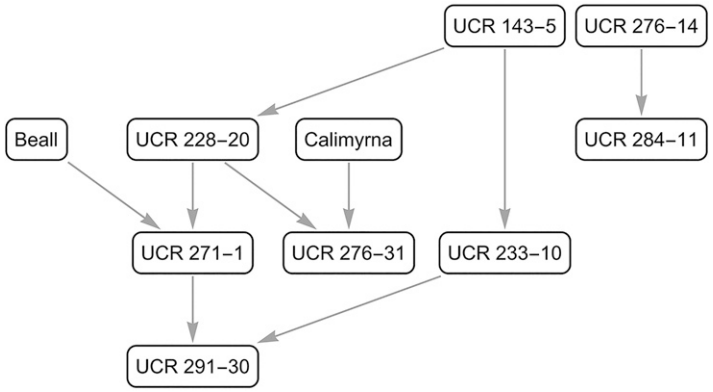

Fig. 2. Intersection of Storey and Germplasm Resources Information Network (GRIN) pedigree records.

transcribed by a custom computer program into tab-delimited data. Fifty-six records containing pedigree descriptions were extracted. Many are compound in form, containing embedded definitions of other specimens. For example, the entry for UCR 143–5 contains the following:

Adriatic × 72–80 [Verdal Longue × (Calimyrna × Kearney)]

which provides a back-hand definition of UCR 72–80 that, in turn, contains an unlabeled reference to Calimyrna × Kearney. Because it is known that UC Riverside grew many offspring of a single cross from multiple seeds (Storey 1975), each of these unlabeled embedded definitions are assumed to be different instances of the cross. As mentioned previously, the cultivar name Kearney cannot be the caprifig of the same name listed in Condit's monograph. It more likely refers to an advanced cultivar from the UC Kearney Agricultural Center.

A parsing program was written to process the "raw" data into individual specimen data with single-cross pedigrees. The program enabled tracking of the original data records and parsing logic contributing to each new record. These two data sets are available in Supplemental Tables 2 and 3.

The simplified pedigree data were placed in a directed topological graph (Agnarsson 2006) for further analysis. The graph contains five components (3 with 3 vertices, 1 with 7 vertices, and 1 large component of 108 vertices) (for details see Supplemental Figs. 1 and 2).

Comparison of Storey's chapter and GRIN pedigrees. An intersection of the specimen labels in the USDA pedigrees with those of W.B. Storey yielded 19 names in common, accounting for the UC Riverside synonyms (Condit 1955) of 'Calimyrna' = 'Sari Lop' and 'Kadota' = 'Dottato' (Table 2). However, the intersection of pedigrees (sets of graph edges) only contains three full pedigrees and four half pedigrees, thus containing a total of 10 specimen labels (Fig. 2).

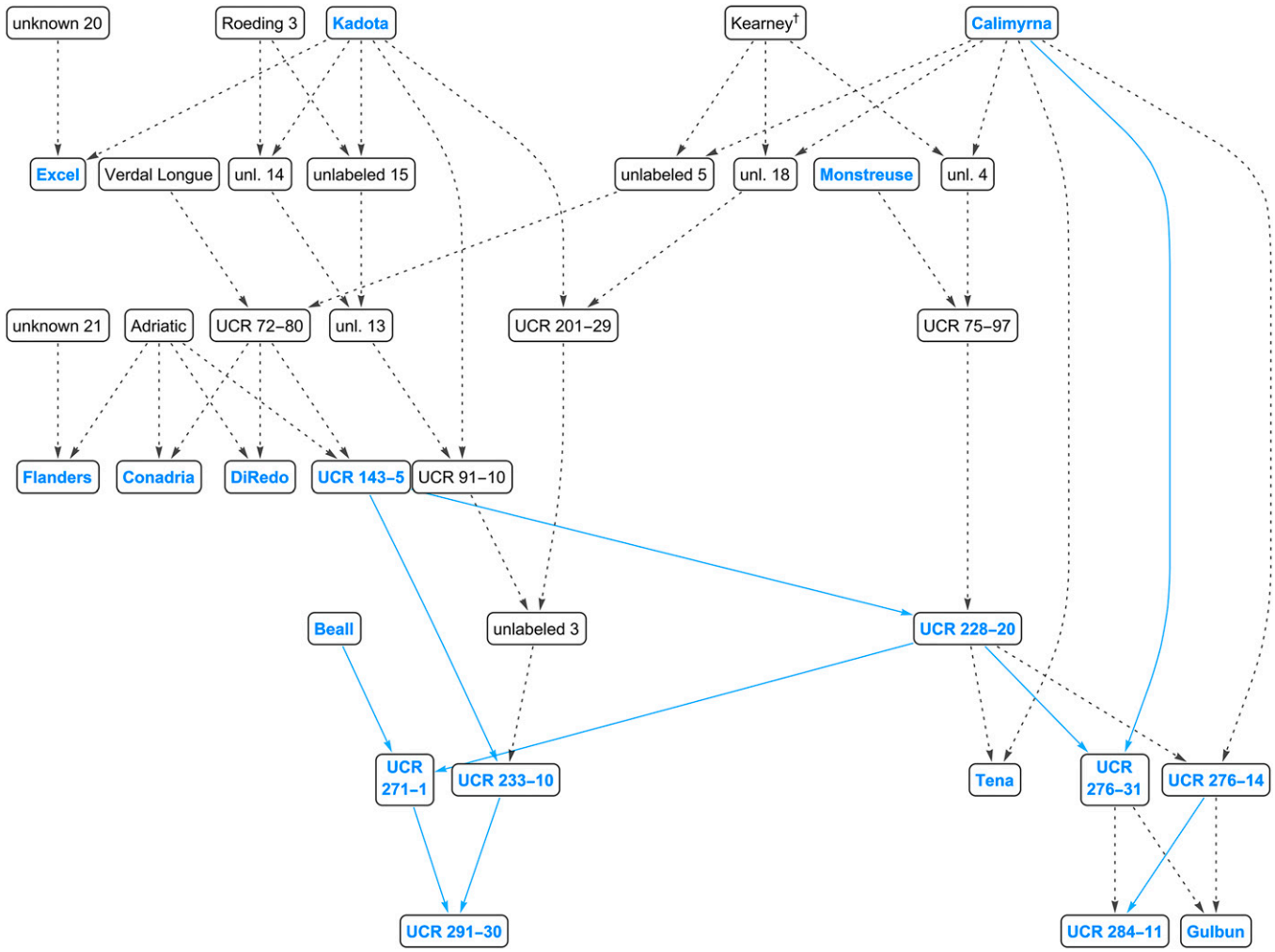

Fig. 3. Storey's specimen labels connected with pedigrees from Germplasm Resources Information Network (GRIN) records. Storey's pedigrees are in blue, and GRIN pedigrees are in black with dashed arrows.

Table 3. Specimen pedigree numbers mentioned in Storey's chapter that currently have records at National Clonal Germplasm Repositories (NCGR).

Storey number	Storey label	NCGR number	NCGR name	NCGR aliases	USDA acquired	USDA donator	NCGR status
113–66		None					
143–35		None					
143–5		DFIC 49	UCR 143–5			UC	Active
151–37		None					
158–46		None					
195–36		None					
228–20		DFIC 8	UCR 228–20		1982	UC	Active
233–10	Yvonne	DFIC 107	UCR 233–10	Yvonne	1982	UC	Active
271–1		DFIC 10	UCR 271–1		1982	UC	Active
276–1		None					
276–14		DFIC 19	UCR 276–14		1982	UC	Active
276–31		None					
276–7		None					
279–57		None					
284–11	Nardine	DFIC 102	UCR 284–11	Gulbun, Nardine	1982	UC	Active
291–30		None					
291–50		None					
291–8		None					

UCR = University of California Riverside; USDA = US Department of Agriculture.

Table 4. Specimen labels mentioned in Storey's chapter that currently have records at National Clonal Germplasm Repositories (NCGR).

Storey label	NCGR number	NCGR name	NCGR aliases	USDA acquired	USDA donator	NCGR status
Beall	DFIC 27	Beall		1982	UC	Active
Conadria	DFIC 5, DFIC 50				UC	Active
Croisic	DFIC 340	Croisic		2008	T. Kennedy	Culled, not true to type
Deanna	None					
DiRedo	DFIC 15	DiRedo		1982	UC	Active
Dottato	DFIC 66	Kadota 1	Dottato	1924 as PI 58643	UC	Active
Evrem	None					
Excel	DFIC 20	Excel		1982	UC	Active
Flanders	DFIC 9	Flanders		1982	UC	Active
F. palmata	DFIC 158			1991	UC	Active
Gulbun	DFIC 102	UCR 284–11	Gulbun, Nardine	1982	UC	Active
Monstreuse	DFIC 67	Monstreuse	Grosse Monstrueuse de Lipari	1906 as PI 18846	Chiswick	Active
Roedings 3	DFIC 133	Roeding 3		1986	Butler Ranch	Active
Saleeb	None					
Sari Lop	DFIC 57	Calimyrna	Sari Lop	1900	G. Roeding[i]	Active
Tena	DFIC 21	Tena		1982	UC	Active

[i] Condit's monograph, page 383.
UC = University of California.

An integrated graph containing all 19 of Storey's specimens was produced by using pedigrees in the GRIN data to "connect" the 10 specimens of Fig. 2 with the 9 remaining outliers. This composition is shown in Fig. 3, where the parentages of several accessions are portrayed in a far more complicated fashion than shown by W.B. Storey. Numbers '228–20' and '233–10' are prime examples. Furthermore, '233–10' is not shown as a parent of 'Gulbun'. Half of the missing parentages of 'Excel' and 'Flanders' are given, and full parentages of 'Conadria' and 'DiRedo' are provided. Again, one can speculate that Storey omitted these parentages and 'Adriatic' altogether as a simplification.

Doyle, Ferguson, and Herman. In a widely circulated conference paper (Doyle et al. 2003), these authors state the following: "The key to the development of hybrid fig seedlings that are persistent or of the "common" type came in 1942 when Dr. Ira Condit discovered a unique type of caprifig growing at Cordelia, CA. This caprifig, thought to be a European cultivar named 'Croisic' …"

It is unclear why Doyle et al. made the aforementioned statement. Condit himself wrote several times that G. Eisen had discovered and identified 'Croisic' in California before 1900. As mentioned, G. Eisen designated 'Croisic' as a category of figs. Furthermore, Condit wrote on page 336 of his monograph that two trees that arrived as part of the Chiswick collection proved to be identical to 'Croisic'. This identification certainly occurred before 1942 because the Chiswick collection arrived during Eisen's tenure in 1894.

Fig specimens at NCGR Davis. A cross-referenced list of names and pedigree numbers used by W.B. Storey that currently appear in the GRIN records for NCGR Davis is given in Tables 3 and 4. Of the 18 pedigree numbers used by Storey, six are listed and are currently active accessions. Of the 12 with names provided by Storey, one ('Yvonne') is matched by NCGR and another ('Nardine') contains both 'Gulbun' and 'Nardine'. Also, among these, the cultivar Conadria exists as accessions DFIC 5 and DFIC 50, but the pedigree '143–5' listed for Conadria by Storey is NCGR accession DFIC 49, and the observation records demonstrate different morphology than that of the first two. Additionally, Storey provided 16 cultivar names in his chapter. These overlap with several of his UCR numbers, but they were considered separately here. Only three of these were not present: 'Deanna', 'Evrem', and 'Saleeb'. A specimen labeled 'Croisic' was not donated until 2008, and it was rejected a few years later because it was not true to type. 'Gulbun' has been within the USDA holdings since 1982, but it is associated with pedigree number '284–11' instead of the value mentioned by Storey.

Conclusions

W.B. Storey's chapter has several shortcomings. A significant portion of the pedigree lineages does not match what has been recorded elsewhere. This could be because of intentional simplification for the purposes of the book. The records transferred during the NCGR consolidation of the 1980s could also contain errors, which, perhaps, will be determined later with robust genomic identification methods.

However, it is disconcerting that several cultivar accessions are mislabeled and his description of parentage for UCR 284 does not match what is given in Table 6. Twice in the chapter, it appears that he confused 'Adriatic' with 'Conadria'. Figure 3 includes the author's best estimate of reconciliation between Storey's pedigrees and those submitted to the USDA.

Storey's account does contain important information regarding fig breeding techniques (pages 575–578). Equally important is his

discussion of crosses with *F. pumila* (presented on pages 582–584). A vining fig adapted to today's indoor agriculture movement is an interesting prospect.

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