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2 The need for collaboration between paleobotanists and neobotanists when using fossils  
3 for calibration of molecular clocks  
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5 Susanne S. Renner and Josef Bogner  
6 Department of Biology, University of Munich, Munich, Germany  
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8 The reliability of molecular clocks depends on their calibration. Calibration is  
9 usually achieved by dividing the genetic distance between sister taxa by the age of the  
10 oldest fossil available for one of the two sister lineages. The thus obtained substitution  
11 rate is then used to estimate the ages of other splitting events in the phylogeny by  
12 dividing the relevant genetic distances by the rate, which yields the time. It is well  
13 understood that all such estimates have large error margins (Sanderson, 1998; Renner,  
14 2005) and that neither strict clocks, which depend on single calibrations, nor relaxed  
15 clocks, which can incorporate more than one constraint for calibration, get around the  
16 problem of having to rely on correctly assigned fossils. (Alternative calibration methods  
17 can sometimes serve for cross validation, but are not always available.)

18 With easy electronic image exchange and the increasing availability of online  
19 libraries and image databases, recent years have seen an increasing flow of information  
20 about fossils between paleobotanists and neobotanists. An example of such a  
21 collaboration is the identification of the fossil USNM 36885, described as *Arisaema*  
22 *hesperia* [but since *Arisaema* is neuter, the ICBN Article 62.1 stipulates that the epithet  
23 must be corrected to *A. hesperium*] by Knowlton (1926), but interpreted as a fruit of  
24 *Liquidambar* by Brown (1946), Hermsen and Gandolfo (2004), and Gandolfo, Nixon,  
25 and Crepet (2008, who render the name as *A. herperia* or *A. heperia*, both incorrect).  
26 Several illustrations of this fossil are available (Knowlton, 1926: pl. X, Fig. 10; Renner et  
27 al., 2004a, online color image <http://www.amjbot.org/cgi/eletters/91/6/881>; Gandolfo et  
28 al., 2008: Fig. 1b). Between June 2002 and June 2003 and again in September 2004, SR  
29 discussed photos of this fossil provided by S. Wing, curator of paleobotany at the  
30 Smithsonian Institution where the fossil is kept, with paleobotanists and neobotanists  
31 with the relevant expertise because she planned to use it to calibrate a molecular clock.  
32 Specialists who kindly commented on photos of the fossil USNM 36885 include  
33 Kathleen Pigg, Steve Manchester, Volker Wilde, Selena Smith, and Jun Wen. Any  
34 misinterpretation of the fossil, of course, is entirely the fault of the neobotantist SR.  
35 Paleobotanists do not misinterpret fossils.

36 USNM 36885 was originally described it in a book-length publication on the flora  
37 of the Middle Miocene Latah Formation near Spokane (Knowlton, 1926). The same plate  
38 that shows *Arisaema hesperium* also illustrates a fruit that Knowlton identified as  
39 *Liquidambar* (l.c.: pl. X, Fig. 10); this fruit has beautiful persistent stigmas. *Liquidambar*  
40 leaves and infructescences are also abundant at the Clarkia and Emerald Creek floras of  
41 northern Idaho (Smiley and Rember 1985), and these again show the characteristic  
42 persistent styles expected in *Liquidambar* (see Rember's website  
43 <http://www.mines.uidaho.edu/~tertiary/images/dirfour/Liquidambar.jpg>). Paleobotanists  
44 whom SR consulted in 2006, S. Manchester (Curator of Paleobotany, Florida Museum of  
45 Natural History, USA) and V. Wilde (Forschungsinstitut Senckenberg, Frankfurt,  
46 Germany), after studying images of USNM 36885 arrived at the view that Knowlton's

47 *Arisaema hesperium* cannot reliably be assigned to *Liquidambar*. A study of  
48 permineralized *Liquidambar* from Yakima Canyon, Washington, that focused on fossils  
49 of essentially the same age as the disputed taxon from the Latah Formation (Pigg, Ickert-  
50 Bond, and Wen, 2004) shows how flattening and weathering prior to fossilization can  
51 alter the appearance of *Liquidambar* fruits (Pigg et al., 2004: Figs. 6 and 10).  
52 Fossilization can cause the loss of styles and of the clear demarcation of the biloculate  
53 condition that characterizes Altingiaceae. However, even in such weathered *Liquidambar*  
54 one finds traces of style bases and of the biloculate condition. The fossil USNM 36885,  
55 by contrast, consists of smooth spherical bodies arranged in a globular head. There are no  
56 traces of styles, only sessile stigma remnants in the center of a few of the spheres.

57 What about Knowlton's assignment of this fossil to Araceae, specifically to  
58 *Arisaema*? Assignment of a fossil depends on a researcher's accumulated expertise and  
59 image databanks. By the time he was working on the Latah fossils, Knowlton had broad  
60 experience, and of course, he knew *Liquidambar* as well as *Arisaema* as living plants as  
61 well as in preserved condition. The Latah strata from which this fossil comes are between  
62 12 and 20 Ma old. Molecular clock studies have used 16-18 Ma (Renner et al., 2004b, c)  
63 or 15.8 my (based on Graham, 1999: p. 262; Renner et al., 2004a). Climate at the latitude  
64 of Washington at that time was already similar to present-day conditions, and the Latah  
65 flora represents a mixed mesophytic forest, with some 75% of (today) Asian species  
66 (Graham, 1999: p. 260). Araceae that occur in North America today are *Arisaema*, *Calla*,  
67 *Colocasia*, *Lysichiton*, *Orontium*, *Peltandra*, *Pistia*, and *Symplocarpus*. If the fossil were  
68 a *Calla*, the remnants of the style and stigma would be visible, while the fossil USNM  
69 36885 clearly only shows the remnants of a sessile stigma. In *Colocasia* and *Peltandra*,  
70 the lower part of the spathe would persist at the base of the inflorescence or  
71 infructescence. *Pistia* has very different inflorescences than the fossil, and in  
72 *Symplocarpus*, the gynoecia and styles are strongly pointed, which likewise does not fit  
73 with '*Arisaema hesperium*.' The inflorescence of *Lysichiton*, finally, is a 10 cm long  
74 cylindrical rod, rather than a globose structure. This leaves *Orontium*, which has thin,  
75 cylindrical inflorescences that in fruit can turn into globose structures (see the fossil  
76 *Orontium* described by Cockerell [1926] from the Eocene, originally thought Miocene, of  
77 Florissant). *Orontium* would fit *Arisaema hesperium* in possessing a small corolla  
78 around each flower, which might correspond to the dark annulus around some of the  
79 globose gynoecia/fruitlets visible in the fossil. On the other hand, the subtending  
80 peduncle in *Orontium* is as broad as the inflorescence/infructescence, which does not fit  
81 with *Arisaema hesperium* with its quite narrow stem. Knowlton (1926: p. 29) writes  
82 about the peduncle "Of the supporting organ or peduncle 3.5 centimeters is preserved, but  
83 it was longer than this, as it runs off the matrix without evidence of attachments. It is  
84 slightly more than 2 millimeters broad and is striate or wrinkled longitudinally, a feature  
85 which indicates that it was fleshy." The striate lines are visible on his photo and one  
86 some of the differently lit recent illustrations of the fossil. That Latah is a mixed  
87 mesophytic forest flora may also argue in favor of *Arisaema*, which is a woodland genus,  
88 while *Orontium* is a semi-aquatic or swamp taxon. In terms of geographic ranges,  
89 *Arisaema* today extends slightly further north than does *Orontium* (Mayo, Bogner, and  
90 Boyce, 1997).

91 Given the morphology and distribution of fossil and extant Araceae (e.g., Wilde et  
92 al., 2005; Bogner et al., 2007; also previous paragraph), Knowlton's assignment of his

93 fossil to *Arisaema* to us remains convincing. A molecular clock analysis of Araceae  
94 (Araceae) that used multiple simultaneous constraints, with minimal and maximal bounds  
95 set by other Araceae fossils (not USNM 36885), found that the disjunctions between the  
96 Asian and North American species of *Arisaema* date to the Oligocene and Miocene  
97 (Renner et al., 2004a), providing validation for the possible presence of an *Arisaema* in  
98 North America at that time. Based on the molecular phylogeny, the three North American  
99 species of *Arisaema*, *A. dracontium*, *A. macrospatum*, and *A. triphyllum*, stem from two  
100 independent colonization events, one around 35-40 my (95% credibility interval 19-55  
101 my), the other possibly as young as 12 my (range 2-28 my).

102 We agree with Hermsen and Gandolfo (2004), and Gandolfo et al. (2008) that  
103 skepticism is appropriate when dealing with neobotanists' naïve assignments of fossils to  
104 nodes in phylogenies. As illustrated by the present case, the only remedy is for  
105 paleobotanists, who know a *Liquidambar* from an Araceae, to help neobotanists.

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109 *hesperium*

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