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1 **Neotypification of the name *Juglandites bergomensis*, basionym of the fossil-**
2 **species *Juglans bergomensis* (*Juglans* sect. *Cardiocaryon*, Juglandaceae)**

3

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18

19 **Abstract**

20

21 *Juglans bergomensis* is the name of a fossil-species belonging to *Juglans* sect. *Cardiocaryon* that is
22 based on the basionym *Juglandites bergomensis*, whose type material, represented by a single fruit,
23 is missing. However, the type locality can be indicated with certainty in the Early Pleistocene
24 brown coal bearing sediments of Lefte, in northern Italy, which yielded several other fossil fruits
25 with characters corresponding to the missing holotype. In the same site fruits of Juglandaceae of
26 different fossil-species occurred. We select a specimen from a collection stored in Padua, with

27 dimensions and sculpture most closely approaching those of the missing holotype, as neotype for
28 the name *Juglandites bergomensis*, in order to fix the application of the name *Juglans bergomensis*.
29 Even if the nuts of this species show “seemingly quite minor” differences from those of *J. cinerea*
30 (smaller seeds, more shallow seed lobes, and generally more elongate shape), it is not convenient to
31 use for these fossils, occurring in Eurasia, the name of the extant North American species. The use
32 of the fossil-species name *J. bergomensis*, taking priority over *J. tephrodes*, permits to establish a
33 clear relationship among several hundreds of Eurasian fossils assignable to sect. *Cardiocaryon*, and
34 to highlight the morphological distinction from a few other fossil-species.

35
36 **Key words:** Italy, Leffe, nuts, palaeontological collections, Pleistocene.

37

38

39 **Introduction**

40

41 *Juglans bergomensis* (Balsamo-Crivelli 1840: 291) Massalongo (1852a: 256) is the name currently
42 applied (Van der Ham, in press) to a fossil-species (see Art. 1.2. of the ICN, McNeill *et al.* 2012)
43 belonging to *Juglans* sect. *Cardiocaryon* Dode (1909: 22) (Juglandaceae), whose nuts occur
44 throughout Europe (Sordelli 1896, Palamarev 1993, Geissert *et al.* 1990, Martinetto in press, Van
45 der Ham in press). It is worth reporting here some information to clear up that *J. bergomensis* has
46 priority over another name still used in recent papers (e.g. Aradhya *et al.* 2007), *Juglans tephrodes*
47 Unger (1850: 469), as already discussed by Sordelli (1874, 1896) and Palamarev (1993). In the first
48 report of this species in the palaeontological record (Castell'Arquato, northern Italy, probably
49 Pliocene), it was assigned by Bronn (1838) to the extant North American species *Juglans cinerea*
50 Linnaeus (1753: 997). Actually, according to the comparative observations of Manchester (1987),
51 the fossil nuts of *J. bergomensis* are more similar to those of the extant *J. cinerea* than to those of
52 the other two extant East-Asian species of sect. *Cardiocaryon* (see Lu *et al.* 1999), i.e. *J.*

53 *ailanthifolia* Carrière (1878: 414) and *J. mandshurica* Maxim. in Maximovicz et Ruprecht (1857:
54 128). The potentially diagnostic characters of *J. bergomensis* are “smaller seeds, more shallow seed
55 lobes, and generally more elongate shape” (Manchester 1987).

56 Section *Cardiocaryon* is indicated as a monophyletic group, in which *J. cinerea* is sister to *J.*
57 *ailantifolia* plus *J. mandshurica* (Fjellstrom & Parfitt 1995, Stanford *et al.* 2000, Stone *et al.* 2009).

58 However, the phylogeography of this section and the divergence time of the single New World
59 species *J. cinerea* are not yet sufficiently known according to Aradhya *et al.* (2007), who even
60 found controversial phylogenetic placements of *J. cinerea* in their molecular study.

61 The name “*Juglandites bergomensis*” Balsamo-Crivelli (1840: 291) was published in the volume of
62 the year 1839 of the journal “Biblioteca Italiana”, whose cover bears the printing date 7 January
63 1840. The author made specific reference to Sternberg (1825: pl. 53, f. 4a–b) for the assignment to
64 the genus *Juglandites* Sternberg (1825: 40) of his new species, even if he repeated two times the
65 orthographical variant “*Juglandites*”, which was corrected to *Juglandites* by Massalongo (1852a:
66 256). Massalongo (1852a) did not check the original specimen of Balsamo-Crivelli, but he listed the
67 name “*Juglandites Bergomensis* Balsam.” as synonym of his name “*Juglans Bergomensis*, Massal.”
68 (1852a: 256). He provided an erroneous reference to the species description (“Not. Nat. sulla Lomb.
69 1844. pag. 77), actually referred to the work of Curioni (1844).

70 Balsamo-Crivelli (1840) did not provide any illustration [not required for valid publication before 1
71 January 1912, see Art. 43.2. of the ICN], but a short description (Fig. 1) based on a single fossil nut
72 from the locality Leffe, which was indeed the holotype (Art. 9.1. of the ICN). This specimen was
73 part of the collection named “Gabinetto de’ minerali e fossili nel locale di Santa Teresa in Milano”,
74 merged into the collection of the Natural History Museum of Milan (MSNM) in the year 1846
75 (Historical Archive of MSNM, envelope 8, 1846, Doc. 26). The last one was severely damaged
76 during World War II with the loss of many original labels.

77 The nut (holotype) studied by Balsamo-Crivelli (1840) was provided by Mr. Botta, owner of a
78 mining company exploiting brown coals on the West side of the Leffe basin, in a stratigraphic

79 position matching the so called “main brown coal seam” (Ravazzi 2003). The age of this level has
80 been assessed at ca. 1.5 Ma ago thanks to the biochronological indications of fossil mammals
81 combined with the magnetic stratigraphy (reverse interval of the Matuyama chron, following the
82 Olduvai subchron: Muttoni *et al.* 2007). An hypothetic provenance of the holotype from younger
83 levels can be ruled out because fossil pollen belonging to *Juglans* sect. *Cardiocaryon* (Ravazzi &
84 Zanni 2001) occurs only in the middle part of the Leffe section, and disappears shortly above the
85 main brown coal unit (Ravazzi & Van der Burgh 1994; Ravazzi & Moscariello 1998), which also
86 yielded other *J. bergomensis* fossil nuts (Omboni 1851, Massalongo 1852a). The early findings of *J.*
87 *bergomensis* at Leffe were promoted by brown coal exploitation activities, starting as early as 1804
88 (Maironi da Ponte 1807).

89 The first drawing (Fig. 2) of “*Juglandites bergomensis*” from Leffe was provided by Omboni
90 (1851: 125), who published the notes taken during the lectures of geology held by Balsamo-Crivelli.
91 In the text associated to this drawing the author cites “nuts” from Leffe, rather than “a nut”; so it is
92 not sure that the drawn specimen was the holotype. In fact at that time (years 1847–51), Balsamo-
93 Crivelli might have at his disposal several fossil nuts from Leffe (part of other collections stored at
94 the MSNM). In this paper we evaluated if the holotype can still be located in the existing collections
95 and if other fossil specimens from the type locality, reliably assignable to the same species, were
96 available in such collections. In any case a type specimen would be necessary because the
97 Juglandaceae fossil fruits occurring at Leffe certainly belong to more than one fossil-species
98 (Ravazzi 2003), and the type of *J. bergomensis* should be available for its future morphological
99 characterization and comparison to fruits of related living species in order to infer phylogenetic
100 relationships.

101

102

103 **Materials and methods**

104

105 The Leffe site is located in the Alps of the Lombardy region, northern Italy (Muttoni *et al.* 2007). In
106 this area there are several repositories of late Cenozoic fossil plant collections (Kustatscher *et al.*
107 2014). We filtered, according to the historical data (Balsamo-Crivelli 1840; Massalongo 1852a,
108 1852b; Sordelli 1896) and to our rather long experience (e.g. Ravazzi & Van Der Burgh 1994;
109 Ravazzi 2003; Martinetto in press), a recently published list (Kustatscher *et al.* 2014: 392) in order
110 to pinpoint the possible repository of the holotype. We also pointed to locate, by means of direct
111 visits, inquiries and image exchanges, other fossil specimens from the Leffe locality referable to the
112 same species as the holotype. We focussed on those specimens that were already labelled
113 *Juglandites bergomensis* or *Juglans bergomensis*, and we analyzed unlabelled fossils only to
114 evaluate their eventual correspondence to the original description of Balsamo-Crivelli (1840). The
115 maximum length and width of the fossils were measured with a caliper, and the presence of
116 longitudinal ribs and their height with respect to the interposed furrows were examined.

117 The search carried out by one of us (G. T.) in Nov. 2014 in the collection of the MSNM, where the
118 holotype was certainly stored in the 19th century, allowed to locate 18 complete and 7 incomplete
119 nut specimens bearing the locality indication "Leffe" (the place of origin of the holotype).

120 We also studied 39 fossil nuts in the collection of the Caffi Natural History Museum of Bergamo
121 (MCSNB), 4 in the collection of the Museum of Geology and Palaeontology of the Padua
122 University (MGP-PD), and 56 in the collection of the Natural History Museum of Verona (MSNV).

123 The MCSNB specimens belong to a 19th century collection from the locality Leffe. The origin of
124 the MGP-PD material is indicated as "from Leffe" in the volume II of the unpublished Catalogue
125 stored in MGP-PD, written by Omboni from the 1873 to the 1875. In this catalogue four specimens
126 of *Juglandites* are indicated, reported with the number 5193, 5194, 5195 and 5196, as a donation of
127 Prof. Lussana to Omboni.

128 The fossil nuts of the collection of the MSNV (MSNV f.678-f.704) most probably represent the
129 material studied by Massalongo (1852a, 1852b), who worked at Verona. In Massalongo (1852a) the
130 origin of the fossil nuts is indicated from the "browncoal of the Bergamasco (Leffe)", a place that

131 the author declares to ignore, having received the fossils by Angelo Milesi. In Massalongo (1852b),
132 *Juglans bergomensis* was reported for the localities "Lefte et Gandino", from which the author
133 additionally described two new species, *J. pilleana* Massalongo (1852b: 261) and *J. milesiana*
134 Massalongo (1852b: 262). Later Sordelli (1874, 1896) merged these two species with *J.*
135 *bergomensis*, and Van der Ham (in press) recently confirmed that *J. pilleana* and *J. milesiana* have
136 to be considered heterotypic synonyms of *J. bergomensis*. All these fossils certainly originate from
137 the vicinity of the village of Lefte [the Gandino village is adjacent to the Lefte one] and the
138 stratigraphic interval of the "main brown coal seam", since all the mines of the 19th century were
139 exploiting such an interval, which is presently inaccessible (Ravazzi 2003).

140

141

142 **Results**

143

144 Our analysis of the fossil nuts in the MGP-PD, MCSNB, MSNM, and MSNV collections allowed
145 us to verify that most of the Juglandaceae nuts from Lefte showed the same basic morphological
146 characters, similar to those observed in the modern samples of *J. cinerea* nuts studied by one of us
147 (R. V.). We confirmed the assignment to *J. bergomensis* of those fruit specimens with length
148 between 27 and 73 mm (Van der Ham, in press), and high ribs alternated to deep furrows, as in the
149 modern *J. cinerea*. However, a few specimens in the MCSNB and MSNV collections have a
150 different external ornamentation, with ribs distinctly lower than in *J. cinerea* and smaller
151 dimensions, so that they certainly belong to another species, not considered in this paper. More
152 detailed information on *J. bergomensis* characters is provided by Van der Ham (in press).

153 The search for the holotype of *J. bergomensis* was unsuccessful. Among the 18 complete
154 specimens of *J. bergomensis* in the MSNM collection, only one specimen (coll. nr. MSNM i3825)
155 partly agreed with the protologue of Balsamo-Crivelli (1840), but this was 6 mm shorter of the
156 length provided by the author (46 mm), so it did not seem to be the holotype. Also in the MCSNB,

157 MGP-PD and MSNV collections there were no specimen that perfectly corresponded to the
158 dimensions of the holotype, which is actually missing. However, the description of Balsamo-
159 Crivelli (1840) and the drawings in Omboni (1851) and Massalongo (1852a, 1852b) are informative
160 enough to be sure that the holotype belonged to the same species more extensively documented by
161 Omboni's and Massalongo's nut specimens from Leffe, respectively preserved at the MGP-PD and
162 at the MSNV.

163 We selected a specimen (coll. number 5196) from the Omboni collection stored at MGP-PD as
164 neotype for the name *J. bergomensis* (Bals.-Criv.) A.Massal, because this nut has the most similar
165 dimensions to the missing holotype (length 42 mm, max. width 23 mm, min. width 15 mm), it is
166 poorly deformed and also remarkably similar as for outline and ornamentation to the first figured
167 specimen of "*Juglandites bergomensis*" (Omboni 1851: 125), drawn under the supervision of
168 Balsamo-Crivelli).

169 We did not choose the MSNM collection for the selection of the neotype because the specimens of
170 *J. bergomensis* do not have a reliable label there, due to the confusion generated during World War
171 II, and the nuts from several localities were listed by Sordelli (1896) as present at the end of the 19th
172 century.

173

174

175 **Typification**

176

177 *Juglans bergomensis* (Bals.-Criv.) A. Massal. Nuovi Ann. Sci. Nat. Bologna 3(6): 256. 1852. —
178 *Juglandites bergomensis* Bals.-Criv. Bibl. Ital. Giorn. Lett, Sci. Arti 95: 291. 1840. **Neotype**
179 (designated here):—ITALY. Bergamo, Leffe, stratigraphic interval of the "main brown-coal seam",
180 Early Pleistocene, *Omboni 5196* (MGP-PD!, Fig. 3).

181 **Additional materials examined** (the acronyms are for the palaeontological collections listed
182 above, and not for herbaria):—ITALY. Bergamo, Leffe, stratigraphic interval of the "main brown-

183 coal seam", Early Pleistocene, *Omboni* (MGP-PD) 5193 (1 fruit), 5194 (1 fruit), 5195 (1 fruit);
184 (MCSNB) 1224A–L (16 fruits), 1225A–S (23 fruits); (MSNM) i3825 (1 fruit), i3288A–J (14
185 fruits), i3289A–J (14 fruits); (MSNV) f.678-f.704 (60 fruits). The provenance from Leffe of the
186 MSNM material is probable, but not sure for each specimen, see above. For other specimens of *J.*
187 *bergomensis* from other Eurasian countries see Van der Ham (in press).

188 **Original description:**—The description provided in Italian (Fig. 1) by Balsamo-Crivelli (1840)
189 can be literally translated as follows: “This nut has a very elongated oval outline, has the husk in the
190 upper part very rugose and ending in a curved acuminate tip. The length of this nut from the husk
191 apex to the nut base is 46 mm, the apex of the husk is of 2 mm, and the maximum width of this fruit
192 is 22 mm”. [The term husk (“mallo”) is most probably improperly used and referred to the shell
193 (nut).]

194

195

196 **Discussion**

197

198 The fossil-species names *J. bergomensis* and *J. tephrodes* are both based on northern Italian nut
199 specimens of the late Cenozoic. *J. tephrodes*, first published by Unger (1950: 469), is evidently a
200 younger heterotypic synonym of *J. bergomensis*, as well as several other names listed by Van der
201 Ham (in press). This last name can be applied to the European fossil nuts belonging to *Juglans* sect.
202 *Cardiocaryon*, rather common in the Cenozoic, due to the valid publication of its basionym
203 *Juglandites bergomensis*, for which we select a neotype originating from the Early Pleistocene
204 deposits of Leffe and stored at MGP-PD. The overview of the collections from the type locality
205 Leffe (presently inaccessible), carried out for the first time by us, shows that several other fossil
206 fruits with characters corresponding to the missing holotype exist in four Italian collections
207 (MCSNB, MSNM, MSNV, MGP-PD). For an overview of the Italian records assigned to *J.*
208 *bergomensis* see Martinetto (in press) and for the European and potential East Asian and North

209 American ones see Van der Ham (in press). This author also confirmed (as suggested by Sordelli
210 1896 and Palamarev 1993) that the first description of a fossil nut of this species was provided by
211 Bronn (1838) under the name *J. cinerea*.

212 As specified above, Manchester (1987) pointed out morphological differences between the nuts of
213 *J. bergomensis* and *J. cinerea*, even if “seemingly quite minor”. Recently, Van der Ham (in press)
214 suspected a ‘lack of clear-cut differences’, but this is not demonstrated, since a careful comparative
215 analysis of the morphological and morphometric characters available in many samples of fossil and
216 modern nuts, including the highly diagnostic internal structure (see Manchester 1987), is still
217 lacking. In the present ambiguous situation the use of the name *J. cinerea*, based on a modern
218 American type (Reveal & Jarvis 2009), for the European fossil nuts (as in Bronn 1838 and Geissert
219 *et al.* 1990) is hazardous. In fact the phylogeography of sect. *Cardiocaryon* and the divergence time
220 of *J. cinerea* are not yet sufficiently known (Fjellstrom & Parfitt 1995, Stanford *et al.* 2000,
221 Aradhya *et al.* 2007, Stone *et al.* 2009) and the Eurasian fossils may represent the nuts of an
222 ancestor and/or of a sister species. The use of the fossil-species name *J. bergomensis* permits to
223 establish a definite relationship among several hundreds of Eurasian fossils (Van der Ham in press),
224 clearly assignable to sect. *Cardiocaryon*, and to highlight the morphological distinction from a few
225 other fossil-species (Manchester 1987, Van der Ham in press). Finally, the use of this name will not
226 preclude a revised assignment of the fossils to one of the modern species of sect. *Cardiocaryon*, in
227 case of future clarification of the phylogeographic issues and/or detection of new and more
228 diagnostic characters.

229

230

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232

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238

239

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323 **FIGURE 1.** Reproduction of the original description in Balasmo-Crivelli (1840) testifying that the name “*Juglandites*
324 *bergomensis*” was validly published.

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326 **FIGURE 2.** The drawing in Omboni (1851) representing "*Juglandites bergomensis*", based on a fossil nut shown by
327 Balsamo-Crivelli to his high-school students. It is not sure that the drawing figures the holotype, since Omboni
328 mentions "nuts" rather than "a nut" in his notes.

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330 **FIGURE 3.** Fossil fruit from the locality Leffe (Early Pleistocene), selected as neotype of *Juglandites bergomensis*
331 Balsamo-Crivelli 1840. Collection Omboni 5196, Museum of Geology and Palaeontology of Padua (MGP-PD). **A.**
332 Lateral view of the side where the nut has a hole showing the internal cavity. **B.** Apical view. **C.** Basal view. **D.** Lateral
333 view showing the junction of the two carpels in the middle.

In questi giorni mi favorì il sig. Botta due noci fossili trovate nella lignite, l'una è una *Juglandites* conosciuta, e di cui il celebre conte de Sternberg ne diede una figura nella sua rinomata opera sovra i vegetabili fossili, tav. 53, fig. 4, a-b, l'altra è certamente una *Juglandites* nuova che chiamar potrebbesi *Juglandites bergomensis*. Questa noce è di figura ovale molto allungata, ha il mallo alla parte superiore molto rugoso e che termina con una punta acuminata ricurva. La lunghezza di questa noce dall'apice del mallo alla base della noce è di millimetri 46, l'apice del mallo è di millimetri due, e la massima larghezza di questo frutto si è di ventidue millimetri.



Frutto interno. Frutto spaccato.

Inglauvites Burgomensis. Walz.

