

## ***Archineura incarnata* (Karsch, 1892) and *Atrocalopteryx melli* (Ris, 1912) in southern China (Odonata: Calopterygidae)**

Zhaoying Guan<sup>a</sup>, Henri J. Dumont<sup>a,b,\*</sup> and Bo-ping Han<sup>a\*</sup>

<sup>a</sup>*Institute of Hydrobiology, Jinan University, Guangzhou-510632, China;* <sup>b</sup>*Limnology Group, Department of Biology, Ghent University, Ghent, Belgium*

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The calopterygines *Archineura incarnata* and *Atrocalopteryx melli* are subtropical habitat specialists, endemic to China, and sensitive to environmental change. We identified several sites with environmental deterioration from which the species seem to have disappeared; these species can be used as indicators of human disturbance. In this paper their distribution in China is mapped and information on their habitat is given, based on literature records (from 1892 until 2012) with supplements from field investigations in 2008–2011. We analysed Chinese literature, which contained much useful information. In all, 57 sites in 12 provinces were found to contain the two species. Suitable habitats occur in small shaded headwater streamlets for *A. melli*, in rocky streams for *Ar. incarnata*. The ranges of both species form an arc that descends from 30°N, then in the east curves inland at the level of the tropic. *Archineura incarnata* is clearly the more common species, but both are perhaps not so rare as hitherto believed. The majority of populations are situated in the provinces of Guangdong, Fujian and Guangxi. Several provinces merit more study, but the absence of both calopterygids from Yunnan might well be real. *Atrocalopteryx melli* populates the mountains of Hainan, while *Ar. incarnata* is absent from the island.

**Keywords:** Odonata; South China; biogeography; Calopterygidae; *Archineura*; *Atrocalopteryx*

### **Introduction**

Dragonflies (Odonata) have acquired a high conservation status, mainly because of their sensitivity to changing aquatic and terrestrial ecosystems (Foote & Hornung, 2005; Remsburg & Turner, 2009). Dragonflies are considered to be sensitive to global climate change (Ott, 2010). Information on their life history and behaviour is summarized in Corbet (1999). With weaker flying abilities than most anisopterans (Dumont, 1975; Dumont et al., 2010; Stettmer, 1996), calopterygid demoiselles are easy prey to visual predators (Corbet, 1999). Therefore, they usually occur in shaded streams, sheltering among trees and bushes. Five families of Calopterygoidea – Calopterygidae, Chlorocyphidae, Euphaeidae, Amphipterygidae and Philogangidae – are found in China. They include about 80 species and are distributed most commonly across southern China, mainly on streamlets in mountain areas at moderate altitudes (Huang, 2007; Zhang, 2010; Zhou, 2007).

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\*Corresponding authors: henri.dumont@ugent.be; tbphan@jnu.edu.cn

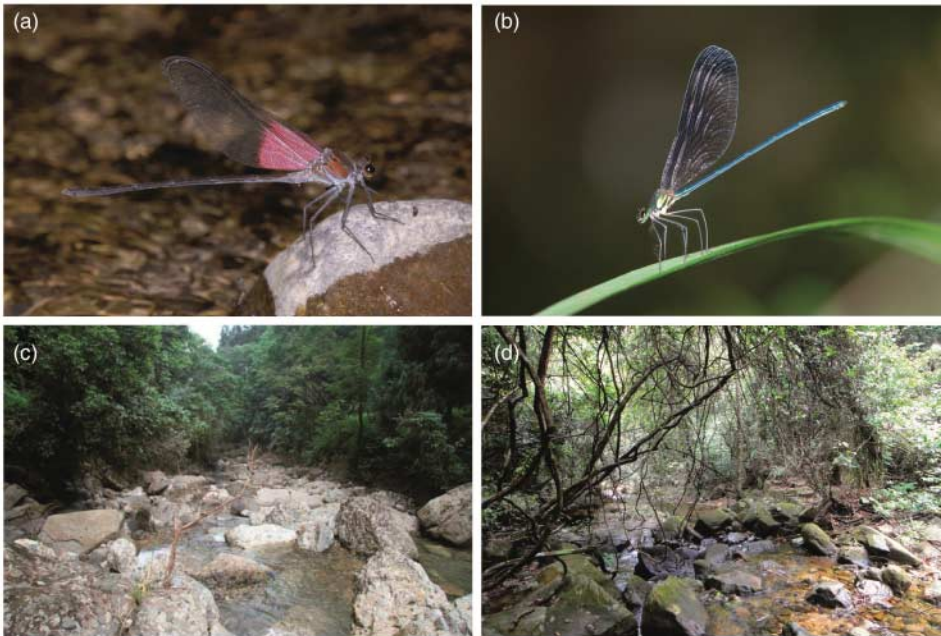


Figure 1. Photographs of *Archineura incarnata* and *Atrocalopteryx melli* and their habitats: (a) *Ar. incarnata* male; (b) *A. melli* male; (c) habitat of *Ar. incarnata* (rocky lowland stream); (d) habitat of *A. melli* (shaded head-water streamlet).

Our knowledge of Chinese Calopterygoidea has progressed considerably in recent years, but has remained inadequate in many details, and no attempts have been made to map the distribution of species.

Few Chinese taxa are to be found in the IUCN red list; in fact, *Atrocalopteryx atrocyana* and *Archineura hetaerinoidea* are the only two that have been listed. Moreover, in the assessment of *Atrocalopteryx*, there is a large information gap about Chinese populations, which affects their conservation status. *Archineura incarnata* (Karsch, 1892) and *Atrocalopteryx melli* (Ris, 1912), which have been called “rare” by Hämäläinen (2004), are two of the large calopterygines of China. Both are endemic to the country, and both have a long flight period (generally from May to October).

*Archineura incarnata* was first described by Karsch (1892) from “Omi-shan” (Emei Shan Mountain, in the Sichuan province of western China) as *Echo incarnata*. Except in Wu (1935), it was not mentioned in the Chinese literature until 1981 (Zhao, 1981) but records became abundant thereafter (Chen et al., 2001a; Huang, 1993, 1999; Su et al., 1993; Sui & Sun, 1984; Wen, 1992; Wu, 1995; Wu & Pan, 2001; Zhao, 1993; Zhu et al., 1998). Male *Ar. incarnata* are easy to distinguish by their large size, dark metallic body and carmine red wing bases (extending for about one-quarter of the wing length); females have yellowish-brown wings and a wing base without red (Figure 1a,b).

*Atrocalopteryx melli* (Ris, 1912) was originally described by Ris (1912) from “Tsa-Yiu-Shan, Kwan-Tung” (25° 30' N, 114°E; its discoverer, a Mr C. Mell, probably a German or Prussian, lived in Canton and probably collected in northern Guangdong province). Morphological descriptions occur in only a few articles by Chinese taxonomists (Huang, 1999; Sui & Sun, 1993; Wu, 1995; Wu & Pan, 2001), and most used the name “*Calopteryx melli*” created by Ris (1912). The reasons for moving this species to the genus *Atrocalopteryx* Dumont et al., 2005, can be found in Dumont et al. (2007) and in a paper by Guan et al. (2012a) updating the phylogeny of the Calopteryginae. *Atrocalopteryx* damselflies have no pterostigma, small or absent postocular tubercles and

veins R2 and IR3 branching together from R4 + 5 (in *Calopteryx* R2 detaches from R + M) (Dumont et al., 2005). *Atrocalopteryx melli* is also a large animal; its remarkable apical brown wing spots (diameter usually 6–8 mm) are opposite to the red ones in *Ar. incarnata*. Significant population differentiation between the mainland and the Hainan Island populations was found in both morphology and genetic traits (for details, see Guan et al., 2012b; and Figure 1c,d).

As the two species are riverine and montane, a better knowledge of their range will help China in protecting valuable streams (water resources) and mountain areas (green habitats).

## Methods

We collected in the field from 2008 to 2011 in 10 provinces (Hainan, Guangdong, Guangxi, Hunan, Fujian, Guizhou, Jiangxi, Yunnan, Zhejiang and Sichuan). Animals were netted and then preserved in 70% alcohol in the field.

We reviewed references from 1892 to 2012 that came to our notice, mainly Chinese papers, of which many were published in local journals. Some of these sources use obsolete names, e.g. Sui and Sun (1993) recorded *A. melli* as *Agrion melli*; most literature before Dumont et al. (2005) mentions *A. melli* as *Calopteryx melli*. *Ar. incarnata* was named *Echo incarnata* by Karsch (1892) and Needham (1930), and this name has been used in most Chinese literature, such as Cao (2006), Chen et al. (2001b, c), Duan et al. (2010), Huang (1993), Su et al. (1993), Sui and Sun (1984, 1993), Xu and Wu (2009), Yu et al. (2009a, b) and Zhu et al. (1998).

Our own new records were combined with those from the literature to compile distribution maps of the two taxa across China.

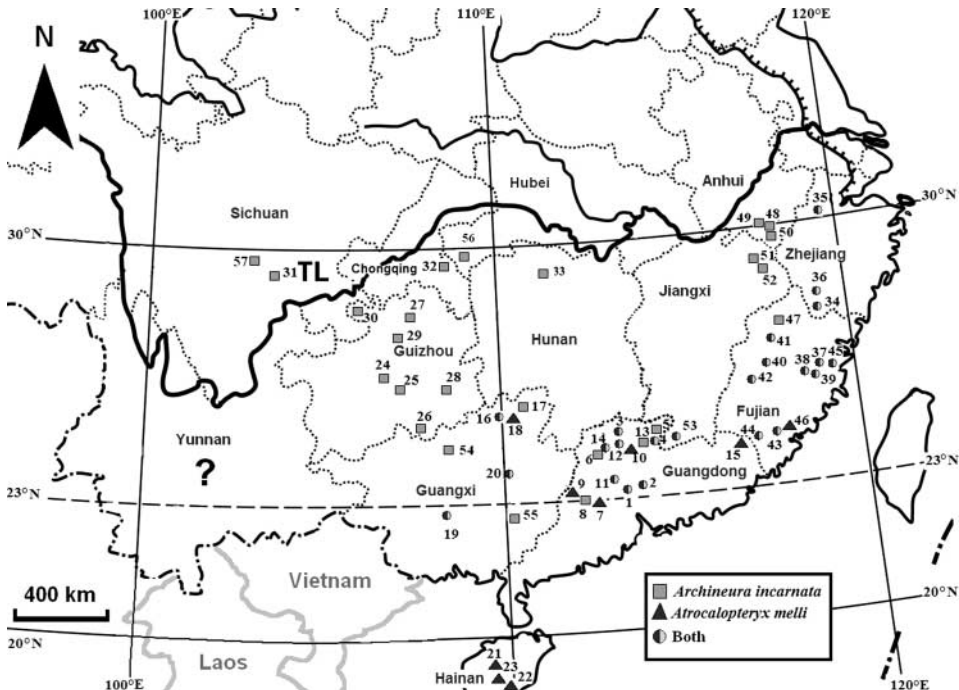


Figure 2. Distribution of *Archineura incarnata* and *Atrocalopteryx melli* in China. Squares: sites for *Ar. incarnata*; triangles: sites for *A. melli*; circles: sites for both species; TL: type locality. Numbers marking the sites are the same in Table 1.

## Results

The sites surveyed by our investigations and literature records are shown in Figure 2 and are listed in Tables 1 and 2. The two species were widely distributed across subtropical China. Historical records show 52 locations from 10 provinces for *Ar. incarnata* and 31 locations in five provinces for *A. melli*. *Archineura incarnata* is abundant in Guangdong, Guizhou and Fujian provinces, and *A. melli* in Guangdong and Fujian provinces. Records from the literature are listed in Tables 1 and 2. Both species appear to share the same northern boundary, which is close to 30°N. Their range on the continent appears to be U-shaped (but see below), and that of *A. melli* is more restricted and coastal (eastern) than that of *Ar. incarnata*. Also, whereas *A. melli* extends to the island of Hainan (as the subspecies *Atrocalopteryx melli orohainani* Guan & Dumont, 2012), *Ar. incarnata* does not. This absence can be considered real: the island has been the subject of numerous investigations, and a conspicuous insect like *Archineura* would not likely escape attention.

Twenty-three locations in total, covering eight provinces, were recorded during our investigation (Table 1, Figure 2). We found four new locations (Zhejiang province: Bai yun yan Nature Reserve in Li shui City; Guangdong province: Pan long xia in De qing Town; Fujian province: small stream in Bai yun village of Yongtai Town; Hunan province: Zhang jia jie Nature Reserve) for *Ar. incarnata* and three for *A. melli* (Shimengtai Mountain-Guangdong; Lishui-Zhejiang; Bai yun village-Fujian).

A clear distinction in behavior and habitat choice was observed between *Ar. incarnata* and *A. melli* (Figure 1c,d). *Archineura incarnata* is mostly found in rocky streams, broader than those where *A. melli* lives. Both males and females of *Ar. incarnata* usually perch on emerging rocks in the streams for most of the day, often mating after noon, and they are powerful fliers. By contrast, *A. melli* only occur in small, shaded headwater streams, commonly during early morning and late afternoon, and even so they tend to lead a more or less discreet life, hiding among dense vegetation. Similar to many habitat specialists, *Ar. incarnata* and *A. melli* can be used as indicators for environmental health and conservation management.

## Discussion

It can be concluded that both species have a similar gross geographical distribution and that they are not rare, but rather are locally abundant in suitable areas of the provinces Guangdong, Fujian and Guangxi. There are 22 overlapping locations for the two species, in four provinces (shown in Figure 2 by circles filled half black and half pale). Overlap means that both occur within the same stream, but *Ar. incarnata* and *A. melli* occupy different reaches. The two species never really co-occur at the same sites because of the strict habitat selection described above.

Countries neighboring China in South Asia could harbor the two species in their border zones, but no records have been discovered. In fact, only the related *Atrocalopteryx atrocyana* and *Archineura hetaerinoidea* seem to occur in Vietnam (IUCN, 2011). *Atrocalopteryx atrocyana* (Fraser, 1935; type locality rather vaguely recorded as “Tonkin”, Vietnam, later correctly labelled to Dong Mo, Lang Son province) does, however, extend into China but is much less common there than *A. melli*. It has been collected in Shimentai Mountain, Yingde County, Guangdong province, where we observed a large population. This is one of only four sites (Table 3) in China. According to Wilson and Xu (2007), and Zhang (2011), *A. atrocyana* usually associates with small, rocky, fast-flowing streams close to the base of mountains.

Guangdong province has the largest numbers of populations for the two species. In addition to the suitable tropical climate, one of the important reasons may be water quality. The Pearl

Table 1. Locations for *Atrocalopteryx melli* and *Archineura incarnata* in southern China, including records from literature and our sampling.

No.	Sites	N	E	Altitude (m)	Records
1	Guangdong-Conghua County-Liuxihe-Sanyatang	23°45'	113°51'	to 1000	Wilson and Xu (2007); our investigation: <i>A. melli</i> and <i>Ar. incarnata</i>
2	Guangdong-Huizhou-Nankunshan Mountain	23°35'	113°45'	200–1100	Wilson and Xu (2007); our investigation: <i>A. melli</i> and <i>Ar. incarnata</i>
3	Guangdong-Shaoguan-Nanling Mountain	24°38'–25°08'	112°40'–113°15'	300–1902	Chen et al. (2001b, c); Fellowes et al. (2003); Kadoorie Farm and Botanical Garden (2003, Report No. 29); Wilson and Xu (2007); our investigation: <i>A. melli</i> and <i>Ar. incarnata</i>
4	Guangdong-Shaoguan-Chebaling Nature Reserve	24°14'–24°46'	114°09'–114°16'	330–1256	Cao (2006); Kadoorie Farm and Botanical Garden (2003, Report No. 32); Su et al. (1993); Wilson and Xu (2007); Zhang (2006); Zhou (2007); our investigation: <i>A. melli</i> and <i>Ar. incarnata</i>
5	Guangdong-Shaoguan-Long tou shan	25°19'46"	114°24'35"	to 1000	Zhang (2006): <i>Ar. incarnata</i>
6	Guangdong-Lian xian- Da dong shan	24°46'29"	112°41'19"	to 900	Zhang (2006): <i>Ar. incarnata</i>
7	Guangdong-Zhaoqing-Dinghushan Nature Reserve	23°10'–23°11'	112°31'–112°34'	140–1000	Wilson (1999); Wilson and Xu (2007); Zhang (2006); our investigation: <i>A. melli</i>
8	Guangdong-Deqing-Panlongxia Mountain	23°20'31.43"	111°49'33.62"	226	our investigation: <i>Ar. incarnata</i>
9	Guangdong-Fengkai-Heishiding Nature Reserve	23°27'–23°30'	111°53'–112°00'	150–900	Xu (2004, 2007); Zhang (2006); Wilson and Xu (2007): <i>A. melli</i>
10	Guangdong-Yingde County-Shimengtai Mountain	24°22'–24°31'	113°05'–113°31'	320–1200	our investigation: <i>A. melli</i> ; Kadoorie Farm and Botanical Garden (2003, Report No. 31): <i>Ar. incarnata</i>
11	Guangdong-Fogang-Guanyinshan Nature Reserve	23°56'18"	113°29'04"	350–1000	Kadoorie Farm and Botanical Garden (2003, Report No. 30); Wilson and Xu (2007); our investigation: <i>A. melli</i> and <i>Ar. incarnata</i>
12	Guangdong-Luokeng Nature Reserve	24°31'	113°20'	to 1200	Wilson and Xu (2007): <i>A. melli</i> and <i>Ar. incarnata</i>
13	Guangdong-Shixing County-Longdoushe	24°41'	113°51'	300–600	Wilson and Xu (2007): <i>Ar. incarnata</i>
14	Guangdong-Yangshan County-Chengjia Nature Reserve	24°47'	112°49'	700	Wilson and Xu (2007): <i>A. melli</i> and <i>Ar. incarnata</i>
15	Guangdong-Dapu County-Fengxi Nature Reserve	24°40'	116°45'	200–800	Wilson and Xu (2007): <i>A. melli</i>
16	Guangxi-Guilin-Huaping Nature Reserve	25°32'11.99"	110°00'28.23"	503	Kadoorie Farm and Botanical Garden (2002, Report No. 15); Wilson and Reels (2003); Zhu et al. (1998); our investigation: <i>A. melli</i> and <i>Ar. incarnata</i>

(Continued)

Table 1. Continued

No.	Sites	N	E	Altitude (m)	Records
17	Guangxi-Guilin-Maoershan Mountain	25°51'35.15"	110°28'54.59"	400	Kadoorie Farm and Botanical Garden (2002, Report No. 16); Wilson and Reels (2003); our investigation: <i>Ar. incarnata</i>
18	Guangxi-Guilin-Qingshitan	25°30'52.70"	110°13'21.05"	208	Kadoorie Farm and Botanical Garden (2002, Report No. 17); Wilson and Reels (2003); our investigation: <i>A. melli</i>
19	Guangxi-Nanning-Damingshan Mountain	23°22'50.90"	108°26'58.20"	238	Wilson and Reels (2003): <i>A. melli</i> and <i>Ar. incarnata</i>
20	Guangxi-Jinxiu-Dayaoshan Mountain	24°08'20.08"	110°06'04.82"	609	Kadoorie Farm and Botanical Garden (2002, Report No. 18); Wilson and Reels (2003); our investigation: <i>A. melli</i> and <i>Ar. incarnata</i>
21	Hainan-Yinggeling Mountain	19°01'	109°09'	200–800	Wilson and Reels (2001): <i>A. melli</i>
22	Hainan-Diaoluoshan Mountain	18°43'30.76"	109°52'06.12"	908	Guan et al. (2012b); Wilson and Reels (2001); Zhou (2007); our investigation: <i>A. melli</i>
23	Hainan-Wuzhishan Mountain	18°13'	109°45'	200–800	Wilson and Reels (2001); Zhou (2007): <i>A. melli</i>
24	Guizhou-Guiyang City-Xiang zhi gou	26°46'27.99"	106°55'09.37"	1040	our investigation: <i>Ar. incarnata</i>
25	Guizhou-Du yun-Dou peng shan Mountain	26°21'35.03"	107°23'00.74"	955	Duan et al. (2010); Zhou (2007); our investigation: <i>Ar. incarnata</i>
26	Guizhou-Xiao qi kong Park	25°43'	107°12'	to 1000	Zhang (2011): <i>Ar. incarnata</i>
27	Guizhou-Kuan kuo shui	28°14'25.14"	107°11'59"	to 1000	Cao (2006); Duan et al. (2010); Zhou (2007): <i>Ar. incarnata</i>
28	Guizhou-Da sha he	28°14'	107°10'	to 1500	Duan et al. (2010); Zhou (2007): <i>Ar. incarnata</i>
29	Guizhou-Lei gong shan	27°14'	107°16'	to 1500	Duan et al. (2010); Zhou (2007): <i>Ar. incarnata</i>
30	Guizhou-Chi shui	28°25'36"	105°43'59"	to 1000	Duan et al. (2010); Zhou (2007): <i>Ar. incarnata</i>
31	Sichuan-E mei shan Mountain (type locality)	29°10'	103°63'	300–1000	Karsch (1892); Needham (1930); our investigation: <i>Ar. incarnata</i>
32	Sichuan-Chongqing-Wu ling shan	29°32'22"	108°37'51"	to 1200	Huang (1993); Zhang (2006): <i>Ar. incarnata</i>
33	Hunan-Zhang jia jie Nature Reserve	29°19'16.48"	110°26'15.42"	88	our investigation: <i>Ar. incarnata</i>
34	Zhejiang-Bai shan zu Nature Reserve	27°10'	119°30'	to 800	Wu (1995); Zhang (2006): <i>A. melli</i> and <i>Ar. incarnata</i>
35	Zhejiang-Tian mu shan Mountain	30°32'	119°61'	200–800	Wu and Pan (2001); Zhang (2006): <i>A. melli</i> and <i>Ar. incarnata</i>
36	Zhejiang-Lishui-Bai yun yan Nature Reserve	28°17'72"	119°14'75"	200–800	our investigation: <i>A. melli</i> and <i>Ar. incarnata</i>

(Continued)

Table 1. Continued

No.	Sites	N	E	Altitude (m)	Records
37	Fujian-Minqing-Bai yan shan Mountain	26°06'06.02"	118°50'38.30"	196	Chen (2009); Xu (2004, 2007); our investigation: <i>A. melli</i> and <i>Ar. incarnata</i>
38	Fujian-Yongtai-Bai yun village	26°01'48.95"	118°54'40.82"	49	our investigation: <i>A. melli</i> and <i>Ar. incarnata</i>
39	Fujian-Yongtai-Tian men shan Mountain	25°49'17.15"	119°00'45.20"	93–250	Chen (2009); Xu (2004, 2007); our investigation: <i>A. melli</i> and <i>Ar. incarnata</i>
40	Fujian-Jiangle-Da ba Power station	26°37'10.32"	117°25'51.80"	188	Chen (2009); Xu (2004, 2007); our investigation: <i>A. melli</i> and <i>Ar. incarnata</i>
41	Fujian-Shaowu-Da bu Town	27°12'24.93"	117°26'44.96"	336	Chen (2009); Hämäläinen (2004); Xu (2004, 2007); Zhao (1981); our investigation: <i>A. melli</i> and <i>Ar. incarnata</i>
42	Fujian-Sanming City-Mingxi County	26°21'40"	117°12'02"	200–600	Chen (2009); Xu (2004, 2007): <i>A. melli</i> and <i>Ar. incarnata</i>
43	Fujian-Zhangzhou City-Hua an County	25°01'25"	117°32'04"	200–600	Xu (2004, 2007): <i>A. melli</i> and <i>Ar. incarnata</i>
44	Fujian-Zhangzhou City-Nanjing County	24°32'49"	117°18'14"	200–600	Xu (2004, 2007): <i>A. melli</i> and <i>Ar. incarnata</i>
45	Fujian-Fuzhou City suburbs	26°10'26"	119°16'40"	200–600	Chen (2009); Xu (2004, 2007): <i>A. melli</i> and <i>Ar. incarnata</i>
46	Fujian-Zhangzhou City suburbs	24°34'52"	117°41'47"	200–800	Chen (2009): <i>A. melli</i>
47	Fujian-Wu yi Mountain	27°41'16.98"	117°44'32.06"	200–800	Chen (2009); Xu (2004, 2007): <i>Ar. incarnata</i>
48	Anhui-Huang shan Mountain	30°06'20.81"	118°01'53.82"	to 1000	Xu and Wu (2009): <i>Ar. incarnata</i>
49	Anhui-Qi yun shan Mountain	29°49'1.614"	118°02'32.13"	to 1000	Xu and Wu (2009): <i>Ar. incarnata</i>
50	Anhui-Ling nan Town	29°26'14.34"	118°10'12.68"	to 1000	Xu and Wu (2009): <i>Ar. incarnata</i>
51	Jiangxi-Dazhang Mountain	28°13'39.27"	117°16'10.75"	to 1000	Yu et al. (2009a): <i>Ar. incarnata</i>
52	Jiangxi-Huaiyu Mountain	28°51'52.27"	117°56'57.19"	to 1000	Yu et al. (2009b): <i>Ar. incarnata</i>
53	Jiangxi-Jiulianshan Nature Reserve	23°29'–24°38'	114°22'–114°31'	to 1000	Kadoorie Farm and Botanical Garden (2003, Report No. 33): <i>A. melli</i> and <i>Ar. incarnata</i>
54	Guangxi-Jiuwanshan Headwater Forest Nature Reserve	25°03'56.51"	108°35'19.92"	to 1000	Kadoorie Farm and Botanical Garden (2002, Report No.14): <i>Ar. incarnata</i>
55	Guangxi-Dapingshan Headwater Forest Nature Reserve	23°32'–23°34'	109°56'–109°59'	200–1158	Kadoorie Farm and Botanical Garden (2002, Report No. 19): <i>Ar. incarnata</i>
56	Hubei-Lichuan, West-Suisapa	29°57'17.77"	109°04'59.71"	1000	Asahina (1969): <i>Ar. incarnata</i>
57	Sichuan-Yachow, West	29°58'58"	103°04'58'	600–2250	Needham (1930): <i>Ar. incarnata</i>

Table 2. Other records for *Archineura incarnata* and *Atrocalopteryx melli* mentioned without detailed locality.

Species	Locations	Records
<i>Archineura incarnata</i>	Guizhou (names of provinces in China, same as follows)	Cao and Yang (2005)
	Hebei	Cao (2006); Duan et al. (2010); Zhou (2007)
	Jiangxi	Cao (2006); Zhou (2007)
	Yunnan	Zhou (2007)
	Guangdong	Wang (2007); Zhang (2010)
	Guangxi	Needham (1930): Lo-chen-hsien (no recent name of any location found referring to it, but may be in Guangxi)
	Sichuan	Asahina (1977): "Szechwan"; Duan et al. (2010); Klots (1947): "Lushan, Lushan, 18 July 1938" (here "Lushan" may be Leshan or Lushan County); Needham (1930): "Lonh Tsi, near Mt Omei, 12 July 1928"
	Hubei	Hämäläinen (2004); Needham (1930); Zhou (2007)
	Hunan	Wen (1992)
	Fujian	Huang (1999); Sui and Sun (1984, 1993); Zhang (1999); Zhao (1993, 1995)
<i>Atrocalopteryx melli</i>	Fujian	Huang (1999); Sui and Sun (1984, 1993)
	Hainan	Huang (2007)

Table 3. Localities for *Atrocalopteryx atrocyana* in southern China.

Sites	N	E	Altitude (m)	Records
A. Guangdong-Yingde County-Shimengtai Mountain	24° 22'–24° 31'	113° 05'–113° 31'	300–1200	Wilson and Xu (2007); our investigation
B. Guangdong-Shaoguan-Nanling Mountain	24° 38'–25° 08'	112° 40'–113° 15'	300–1902	Wilson and Xu (2007)
C. Guizhou-Libo County-Maolan National Nature Reserve	25° 31'–25° 35'	107° 87'–107° 94'	300–1000	Zhang (2011); Zhou (2007)
D. Guangxi	No detail recorded			Zhou (2007)

River Basin, which is the only large (length 2214 km, area 454,000 km<sup>2</sup>) river system of the province, has the best water quality among the seven major river basins of China (Ma, 1999). On the other hand, fewer *Ar. incarnata* or *A. melli* are found in the coastal region compared with the other parts of the province, perhaps because a large number of industries (e.g. paper manufacturing) is located in this area (Ma, 1999). This area is also one of the most urbanized (developed) in China, and during the past 60 years of urbanization, the coastline region has developed very fast (records from National Administration of Surveying, Mapping and Geoinformation: <http://www.sbsm.gov.cn/>, and China Statistical Yearbooks Database: <http://tongji.cnki.net/overseas/engnavi/navidefault.aspx>). Their absence suggests that the two species can indeed be used as indicators of environmental change.

In the literature, we found no reference to *Ar. incarnata* or *A. melli* in Yunnan province, and few in Sichuan. Further investigation will also show whether any *Ar. incarnata* and *A. melli* still live in Yunnan provinces (see question marks on map in Figure 2). The two species could be locally extirpated as habitats become affected by human impacts, e.g. urbanization, farmland expansion and deforestation. The reverse may also occur, i.e. more sites will be found as more investigations take place. Similar situations should occur in Guizhou and Zhejiang province, where we did not find the species in areas mentioned in the literature.

There are still some "blank fields" in Figure 2 that need to be visited. For example, *A. melli* may live in the southwestern area of Guangdong, next to Hainan province because it is known



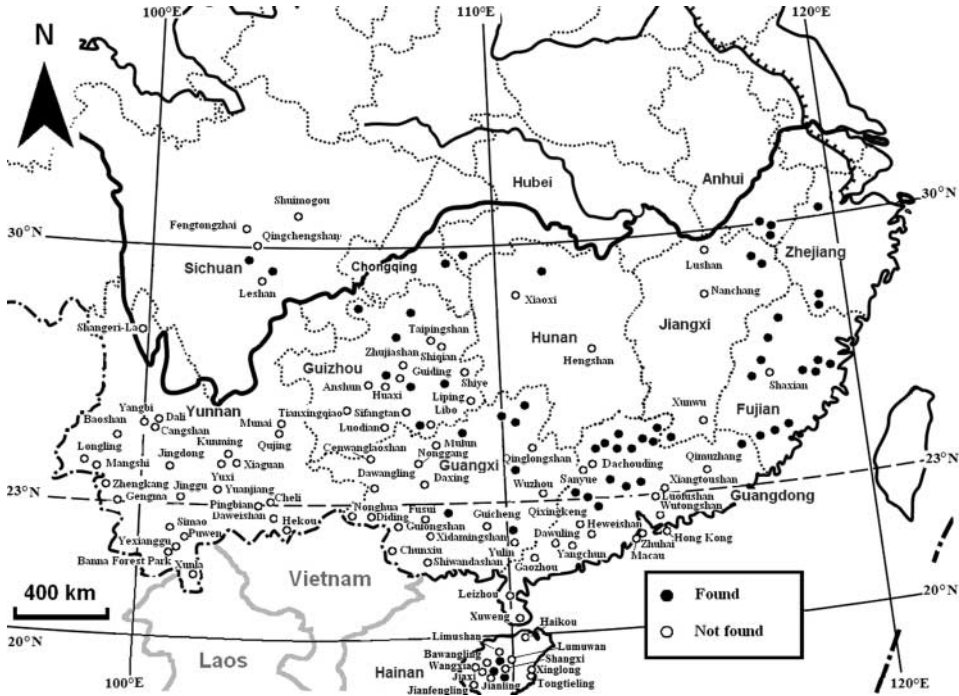


Figure 3. Locations of sampling records in China. Black spots: sites where *Archineura incarnata* or *Atrocalopteryx melli* are found; white spots: sites where there are no records for the two species. The names of sites where the two species were not found are shown on the map next to the “white spot” marks. (Records taken from our sampling and from references: Zhao, 1994; Wilson and Reels, 2001, 2003; Hämäläinen, 2004; Zhou, 2007; Wilson and Xu, 2007; Kadoorie Farm and Botanical Garden, 2001–2004, report No. 2–39).

from Hainan. The southern parts of Hunan and Jiangxi provinces, where records are almost non-existent, are close to Guangdong province where we found plenty of populations. Moreover, the riverine and mountainous environments in southern Hunan and Jiangxi are similar to those of Guangdong. The same situation is found in Yunnan and Sichuan. The record in Zhou (2007) did not mention a locality for *Ar. incarnata*, and for Sichuan province, most of the records are from old European literature, at a time when people could not search far away from population centers. That is probably why the type locality of *Ar. incarnata* is Emei Shan Mountain of Chengdu City. Similarly, another other old record by MacLachlan (1894), containing the type locality for *Atrocalopteryx oberthueri*, “Ta-chien-lu” (current spelling in Pinyin “Da Jian Lu”) was also part of the larger Chengdu.

Yunnan and Sichuan need to be better explored but it is instructive to map the sites where former researchers collected dragonflies but did not find our two calopterygids. These amount to 146 sites in total (Guangdong: 31; Yunnan: 25; Guangxi: 23; Guizhou: 19; Hainan: 14; Fujian: 12; Sichuan: 7; Jiangxi: 5; Zhejiang: 3; Anhui: 3; Hunan: 3; Hubei: 1), 89 locations have no record for *A. melli* or *Ar. incarnata* (shown as white spots on the map in Figure 3).

It therefore appears that, especially in Yunnan province, there is no record for the two species in 25 sites visited (see Zhao, 1994; Zhou, 2007), which indeed suggests that they are not there. In Hunan, in contrast, with only two records, clearly more research is needed.

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